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2. When the respiratory orifices are closed, the variations of blood-pressure in the arteries are synchronical with those of air-pressure in the respiratory cavity, and take place in the same direction.

3. The increased action of the heart which results from chemical changes produced in the circulating fluid by exposure to air, is of the same nature as the mechanical effect of inspiration, both being indicated by increased arterial tension and acceleration of the pulse. The former may be distinguished from the latter (*a*) by the length of time required for the production of the effect, and (*b*) by its dependence on a previous venous condition of the blood.

4. Hence the influence of the thoracic movements on those of the heart may be either directly mechanical, as in suffocation, indirectly mechanical, as in ordinary breathing, or chemical.

March 14, 1867.

Lieut.-General SABINE, President, in the Chair.

The following communications were read:—

I. "Note on Mr. Merrifield's New Method of calculating the Statical Stability of a Ship." By W. J. Macquorn Rankine, C.E., LL.D., F.R.S. Received February 22, 1867.

On the 24th of January, 1867, a paper was read to the Royal Society by Mr. C. W. Merrifield, F.R.S., Principal of the Royal School of Naval Architecture, showing how, by determining the radii of curvature of the locus of the centre of buoyancy or "metacentric involute" of a ship in an upright position and at one given angle of inclination, a formula may be obtained for calculating to a close approximation her moment of stability at any given angle of inclination, on the assumption that the metacentric involute can be sufficiently represented by a conic.

It has occurred to me that the latter part of the calculation in Mr. Merrifield's method might be simplified by assuming for the approximate form of the metacentric involute, not a conic, but the *involute of the involute of a circle*; the locus of its centres of curvature, or "metacentric evolute," being assumed to be the involute of a circle.

The involute of the involute of a circle is distinguished by the following property. Let r be the radius of the circle, ρ_0 that radius of curvature of the involute of the involute which touches the involute at its cusp, and ρ another radius of curvature of the same curve making the angle θ with the radius ρ_0; then

$$\rho=\rho_0+\frac{r\theta^2}{2}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Having found, then, the radii of curvature of the metacentric involute in an upright position, and at a given angle of inclination θ_1, let ρ_0 and ρ_1 be those radii respectively; then make

$$r=\frac{2(\rho_1-\rho_0)}{\theta_1^2}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \qquad (2)$$

This will be the radius of the required circle; and its positive or negative sign will show whether it is to be laid off downwards or upwards from the metacentre. For any given angle of inclination the radius of curvature of the metacentric involute will be given by equation (1), which may also be put in the following form:

$$\rho=\rho_0+(\rho_1-\rho_0)\frac{\theta^2}{\theta_1^2}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \qquad (3)$$

Let δ be the depth of the ship's centre of gravity below her metacentre, and p the perpendicular let fall from that centre of gravity upon the radius of curvature of the metacentric involute at any given angle of inclination θ; then

$$p=(\delta-r)\sin\theta+r\theta; \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \qquad (4)$$

and the moment of stability is

$$p\times \text{displacement}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \qquad (5)$$

It is obvious that the condition of *isochronous rolling* is that $\delta-r=0$; that is to say, that the centre of the circle which is the evolute of the metacentric evolute shall coincide with the ship's centre of gravity; a proposition already demonstrated by me in a paper read to the Institution of Naval Architects in 1864, and published in their Transactions, vol. v. p. 35.

[*Postscript.*—Received March 11, 1867.]

Since the above was written, I have been informed by Mr. Merrifield, to whom I had communicated my proposed modification of his method, that it has been tried at the Royal School of Naval Architecture and found to answer well.

II. "On the Theory of the Maintenance of Electric Currents by Mechanical Work without the use of Permanent Magnets." By J. Clerk Maxwell, F.R.S. Received February 28, 1867.

The machines lately brought before the Royal Society by Mr. Siemens and Professor Wheatstone consist essentially of a fixed and a moveable electromagnet, the coils of which are put in connexion by means of a commutator.

The electromagnets in the actual machines have cores of soft iron, which greatly increase the magnetic effects due to the coils; but, in order to simplify the expression of the theory as much as possible, I shall begin by